A Risk-Hedged Approach to Traffic Flow Management under Atmospheric Uncertainties, Phase I

Completed Technology Project (2012 - 2012)

Project Introduction

Volcanic ash and other atmospheric hazards impact air transportation by introducing uncertainty in the National Airspace System (NAS) capacity. Deterministic traffic flow management (TFM) algorithms are often unable to perform efficiently in these conditions, motivating the development of probabilistic TFM algorithms. It has been shown that these algorithms result in a Stochastic Linear Program (SLP), whose structure is relatively simple due to elegant theory, but which can be hard to solve in realistic time frames due to computational complexity. This proposal has three objectives. The primary objective is to translate the volcanic ash phenomenon into airspace capacity uncertainty distributions. The second objective is to design probabilistic TFM algorithms using an SLP solver on a Graphics Processing Unit (GPU) to tame the computational complexity of the problem. The third objective addresses the fact that current probabilistic TFM formulations leave the variance in the system unchanged. Consequently, the system may exhibit unintended variance, causing delays and congestion in the NAS. Variance in delays and the mean delay cannot be minimized together because the exact tradeoff is not known a priori. Concepts from Modern Portfolio Theory (MPT) are introduced, that can formulate and solve a multi-objective optimization problem in the mean as well as variance of the system delay. Using MPT and SLP, risk-hedged strategies for aircraft scheduling are obtained to mitigate the effects of atmospheric hazards. In Phase I, volcanic ash models will be researched, and a framework for obtaining capacity uncertainty distributions due to volcanic activity will be developed. The SLP solver will be implemented on the GPU. Finally, a portfolio-theoretic approach to risk-hedged trajectories will be researched. Phase II work will extend results to a large scale NAS simulation, with more advanced volcanic ash and atmospheric disruption models.

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Small Business Innovation Research/Small Business Tech Transfer

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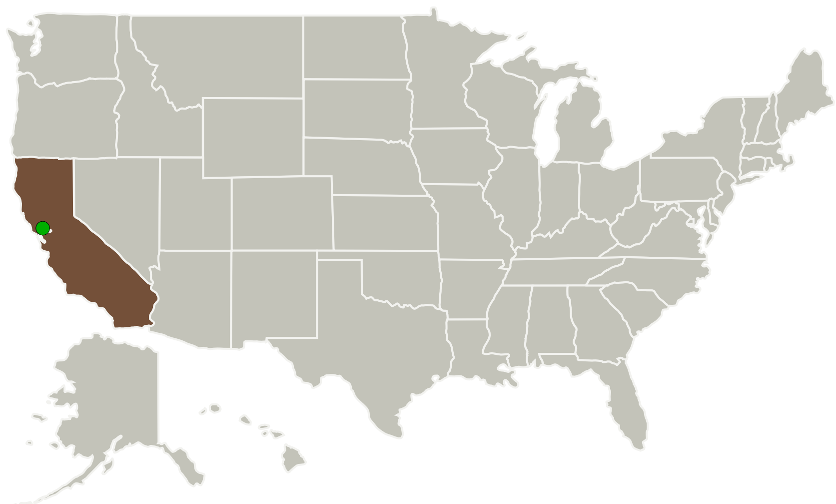
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Optimal Synthesis, Inc.	Lead Organization	Industry Small Disadvantaged Business (SDB)	Los Altos, California
Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations
California

Project Transitions

February 2012: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Optimal Synthesis, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

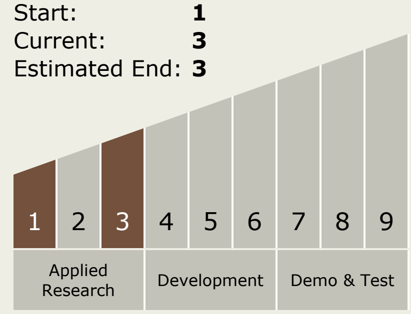
Carlos Torrez

Principal Investigator:

Prasenjit Sengupta

Technology Maturity (TRL)

Start: **1**
Current: **3**
Estimated End: **3**



August 2012: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137924)*

Technology Areas

Primary:

- TX16 Air Traffic Management and Range Tracking Systems
  └─ TX16.3 Traffic Management Concepts

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System